



Société Française
de Physique
COMMISSION JEUNES



4TH French Physicists' Tournament

3 & 4 FÉVRIER 2017

École normale supérieure, Paris

Captains' fight

Captains' fight n°3 : Question

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You have **3 minutes** to answer the following question :

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What would be the linear size **in meters** of a cube made of gold of the same mass as the atmosphere ?

Captains' fight n°3 : Answer

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The atmospheric pressure corresponds to the weight of an air column of 1 m^2 , corresponding also to a 10 m-high column of water, thus $1\cdot 10^4\text{ kg}$. Multiplying this mass by the surface of the Earth, we get

$$M_{\text{atm}} \simeq 4\pi(6400 \cdot 10^3)^2 \cdot 10^4 = 5,1\cdot 10^{18}\text{ kg}.$$

Gold has a density $d_{\text{gold}} \simeq 20$, such that $\rho_{\text{gold}} \simeq 20\cdot 10^3\text{ kg}\cdot\text{m}^{-3}$. The volume of the cube is

$$V_{\text{gold}} \simeq \frac{5,1\cdot 10^{18}}{20\cdot 10^3} \simeq 2,6\cdot 10^{14}\text{ m}^3$$

The height of the cube is then

$$\boxed{L_{\text{gold}} \simeq 4,0\cdot 10^4\text{ m}} \quad \log_{10} L = 4.6$$

You want more?

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Really?

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Quick : 1min

Question : If you manage to drive all the water of the Niagara falls inside a straw, what would be the speed (in $\text{m}\cdot\text{s}^{-1}$) of the water ?

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Answer

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Answer

The typical flow rate of Niagara falls is $2\,800\text{ m}^3\cdot\text{s}^{-1}$ (*value taken from Wikipedia. This can be estimated knowing that the falls are 1 km long !*).

The surface of a straw is typically $\pi \times \frac{(10^{-2})^2}{4} = 1\cdot 10^{-4}\text{ m}^2$.

The velocity is thus :

$$v = \frac{2800}{10^{-4}} = \boxed{2,8\cdot 10^7\text{ m}\cdot\text{s}^{-1}} \quad \log_{10} v = 7,4$$

(10^7 wins against 10^8)