Captains' fight

Captains' fight n°4: Question

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

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Question: You are on a boat directly over the Mariana Trench. If you drop a 7 kg bowling ball over the side, how long would it take to hit the bottom?

Captains' fight n°4: Answer

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1. The actual first question to answer is: is the flow laminar or turbulent? That will drastically change the drag law. Let's calculate the Reynolds number of a bowling ball in water:

$$\mathrm{Re} = \frac{\rho_\mathrm{e} v L}{\eta} = \frac{10^3 \times v \times 0.1}{10^{-3}} = 10^5 v \tag{1}$$

   where $\eta = 10^{-3}$ Pa·s is the dynamic viscosity of water, v the velocity of the ball, $L = 11$ cm is the ball radius and $g = 9{,}81\,\mathrm{m/s^2}$. So even if v is as small as $1\,\mathrm{m{\cdot}s^{-1}}$, the flow will be turbulent.
2. The flow being turbulent, drag is proportional to the velocity squared (different from Stokes' law for laminar flow). The ball undergo a force which is, by dimensional analysis:

$$F_x = \frac{1}{2}\rho_\mathrm{e} S C_x v^2 \tag{2}$$

   where S is the projected surface (πR^2 for a sphere), C_x is a dimensionless coefficient. For a sphere with $\mathrm{Re} > 10^3$, C_x is constant to $C_x = 0.44$. Such that in stationary state:

$$mg - \rho_\mathrm{e} V g - \frac{1}{2}\rho_\mathrm{e} S C_x v^2 = 0 \tag{3}$$

   i.e. for a sphere ($V = \frac{4}{3}\pi R^3$, $S = \pi R^2$)

$$v = \sqrt{\frac{8}{C_x}\frac{\rho - \rho_e}{\rho_e} R g} = \sqrt{\frac{8}{0.44}\frac{0.2 \times 10^3}{10^3} 0.11 \times 9.81} = 1{,}98\,\mathrm{m{\cdot}s^{-1}} \tag{4}$$

3. Finally, forgetting about the transitory phase (a few seconds), $L = v\tau$ with $L = 11\,034$ m,

$$\boxed{\tau = 5\,573\,\mathrm{s} = 93\,\mathrm{min} = 1\,\mathrm{h}33\,\mathrm{min}} \tag{5}$$

You want more?

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Really ?

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Quick: 1min

Question: How many orders of magnitude are there between the highest and lowest artificially obtained temperatures?

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Really ?

Quick: 1min

Question: How many orders of magnitude are there between the highest and lowest artificially obtained temperatures?

Answer

You want more?

Really ?

Quick: 1min

Question: How many orders of magnitude are there between the highest and lowest artificially obtained temperatures?

Answer

- Hottest temperature : quark and gluon plasma at LHC : 5×10^{12} K
- Lowest temperature : adiabatic demagnetization : 5×10^{-10} K
- Thus: $\boxed{\text{22 orders of magnitude}}$.