Dimensional Analysis Training Problems

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1

1. Use drawings and explain the meaning of $\dot{A}$.

2. Use drawings and interpret the meaning of $\dot{V}$.

3. Explain the meaning of $\dot{\rho}$ and give an example.

4. Fill in this table.

Quantity	Dimensions	MKS units
$\dot{x}$		
$\dot{A}$		
$\dot{V}$		
$\dot{m}$		
$\dot{\rho}$		
$\dot{p}$ (momentum dot)		
$\dot{W}$		
Newton's dot, $\cdot$		

5. Guess a relationship between ρ, $\dot{m}$, v and A by examining the dimensions of these quantities.

6. Use the *abc* method to find a relationship between the quanitites in **5**.

7. Interpret the meaning of the relationship in **5**. Use drawings.

8. Consistent or inconsistent? Do them carefully using the square bracket $[q]$ notation.

(a) $p = p_0 + \rho g h$.

(b) $\rho = \rho_0 + p g h$.

where p is pressure.

9. Consistent or inconsistent?

(a) $m = \dfrac{m_0}{\sqrt{1 - v^2}}$.

(b) $m = \dfrac{m_0}{\sqrt{1 - \dfrac{v^2}{c^2}}}$.

where c is the speed of light.

10. A tank of liquid mercury is sitting with the top open to the atmosphere. Atmospheric pressure is $101,000\,\text{Pa}$. Use Pascal's law to determine the pressure $150\,\text{cm}$ below the surface. The density of liquid mercury ρ_{Hg} is $13,500\,\text{kg/m}^3$.

11. Use your imagination and determine a relationship between time, work and power. Think about machines doing work and draw some cartoons. That will help you figure it out.

12. The kilowatt-hour is a unit used by electric companies. It's a kilowatt times an hour. What kind of unit is this? What are the dimensions? What is $1\,\text{kW}\cdot\text{hr}$ in MKS units?

13. A horsepower is a unit of power often used to describe engines and big machines. One horsepower is about 745.7 Watts. An Alfa-Romeo Quadrifoglio has a $500\,\text{hp}$ engine. What is that in MKS units?

14. A machine can do $120,000\,\text{Joules}$ of work in 1 minute. What is the power of this machine?

15. How much energy does a $60\,\text{W}$ lightbulb use if you leave it on for 12 hours?