

Show all calculations. Explain all assumptions. Answer in standard MKS units.

Explicitly substitute units into your symbolic equations to verify solution.

Express answers in 5 or fewer digits. Use scientific notation as appropriate.

Conceptual Questions: Place the letter corresponding to your answer in the box.

Limit your explanation to the space provided. Please write legibly.

1. Is it possible for two quantities to have the same units, but different dimensions?

B

- a) Yes, of course.  
 b) No, of course not.  
 c) Depends on other information.  
 Explain

Since dimensions are aspects of the universe (length, mass, time) you cannot use units of one dimension to describe another...

for example mass = 10 seconds  
 or meters = kilograms  
 are nonsensical statements

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2. Is it possible for two quantities to have the same dimensions, but different units?

A

- a) Yes, of course.  
 b) No, of course not.  
 c) Depends on other information.  
 Explain

Yes, the dimensions may be expressed in any number of units...

one inch, 2.54 cm, 254 mm  
 etc, are all ways to describe the dimension of length

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Due on or before 9/4

Show all calculations. Explain all assumptions. Answer in standard MKS units.  
 Explicitly substitute units into your symbolic equations to verify solution.  
 Express answers in 5 or fewer digits. Use scientific notation as appropriate.

3. Is it possible for one component of a vector to be zero, while the vector itself is not zero?

A

- a) Yes, of course.  
 b) No, of course not.  
 c) Depends on other information.  
 Explain

a vector may be described with respect to any axis, so a vector  $A = 9(+\hat{y})\text{m}$  could be written as  $\vec{A} = \vec{A}_x + \vec{A}_y = \emptyset + 9\text{m}(+\hat{y})$

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4. Is it possible for one component of a vector to be non-zero, while the vector itself is zero?

B

- a) Yes, of course.  
 b) No, of course not.  
 c) Depends on other information.  
 Explain

no. for a vector to be zero means that no matter which axis is taken as reference the vector magnitude must be zero.

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Due on or before 9/4

$$a) F = ma = \text{kg} \frac{\text{m}}{\text{s}^2} = \boxed{\frac{\text{kgm}}{\text{s}^2}} \quad 5$$

$$b) \frac{F}{A} = P = \frac{\text{kg} \frac{\text{m}}{\text{s}^2}}{\text{m}^2} = \boxed{\frac{\text{kg}}{\text{ms}^2}} \quad 5$$

$$c) F \cdot X = E = \left( \frac{\text{kgm}}{\text{s}^2} \right) (\text{m}) = \boxed{\frac{\text{kgm}^2}{\text{s}^2}} \quad 5$$

$$d) \frac{E}{m} = \phi = \frac{\text{kgm}^2/\text{s}^2}{\text{kg}} = \boxed{\frac{\text{m}^2}{\text{s}^2}} \quad 5$$

lol. cops.

$$e) \beta = V \left( \frac{P}{V} \right) = P \quad \frac{P}{\rho} \quad \rho = \frac{m}{V} = \frac{\text{kg}}{\text{m}^3}$$

$$\frac{\text{kg}/\text{ms}^2}{\text{kg}/\text{m}^3} = \frac{\text{m}^3}{\text{ms}^2} = \frac{\text{m}^2}{\text{s}^2} ; \sqrt{\frac{\text{m}^2}{\text{s}^2}} = \boxed{\frac{\text{m}}{\text{s}}} \quad 5$$

$$f) \mu = \frac{\text{kg}}{\text{m}} \quad \frac{F}{\mu} = \frac{\text{kgm}/\text{s}^2}{\text{kg}/\text{m}} = \frac{\text{m}^2}{\text{s}^2} ; \sqrt{\frac{\text{m}^2}{\text{s}^2}} = \boxed{\frac{\text{m}}{\text{s}}} \quad 5$$

$$V = NF^a (M/L)^b = NF^a M^b L^{-b}$$

$$L^1 T^{-1} = NF^a M^b L^{-b}$$

$$= N(M^a L^a T^{-2a})(M^b)(L^{-b})$$

$$L^1 T^{-1} = N M^{a+b} L^{a-b} T^{-2a}$$

since  $M^0 = 1$  - could write the equation as

$$M^0 L^1 T^{-1} = N M^{a+b} L^{a-b} T^{-2a}$$

$$\therefore a+b = 0 \Rightarrow a = -b$$

$$a-b = 1 \quad a = b+1$$

$$-2a = -1$$

$$\boxed{a = \frac{1}{2}, b = -\frac{1}{2}}$$

one acre  $\sim 43,560 \text{ ft}^2$

one acre-foot =  $43,560 \text{ ft}^3$

1 foot  $\sim 0.305 \text{ m}$

$$43,560 \text{ ft}^3 \times \frac{1 \text{ m}}{3.28} \left( \frac{0.305 \text{ m}}{1 \text{ ft}} \right)^3 = \boxed{1235.9 \frac{\text{m}^3}{\text{acre-foot}}} \quad 10$$

with  $\rho_{\text{H}_2\text{O}} = 10^3 \frac{\text{kg}}{\text{m}^3}$

$$\boxed{1.236 \cdot 10^6 \frac{\text{kg}}{\text{acre-foot}}} \quad 10$$

with 1 liter =  $10^{-3} \text{ m}^3$      $10^3 \frac{\text{l}}{\text{min}} \times 10^{-3} \frac{\text{m}^3}{\text{l}}$

$$= \frac{1 \text{ m}^3}{\text{min}} \circ 1235.9 \frac{\text{m}^3}{\text{acre-foot}} \times \frac{1 \text{ min}}{\text{m}^3}$$

$$= 1235.9 \frac{\text{min}}{\text{acre-foot}} \times \frac{60 \text{ sec}}{\text{min}} = \boxed{7.42 \cdot 10^4 \text{ s}} \quad 10$$

$\frac{\text{volume}}{\text{drop}} \times \frac{N \text{ drops}}{\text{m}^2 \text{ s}} \times \text{Time} = \frac{N \text{ Volume}}{\text{m}^2} \times \text{Area} = \text{volume} \dots$

$$V_{\text{drop}} \sim \frac{4}{3} \pi r^3 \quad N_{\text{drop}} = 1.275 \cdot 10^3 \frac{\text{drops}}{\text{m}^2 \text{ s}} \quad T = 8 \text{ hr} \times \frac{3600 \text{ s}}{\text{hr}}$$

$$\text{Area} = (3 \cdot 10^3 \text{ m}) (4 \cdot 10^3 \text{ m}) = 12 \cdot 10^6 \text{ m}^2 \quad \text{so} \dots$$

$$\frac{4}{3} \pi \left( \frac{2 \times 10^{-3} \text{ m}}{d} \right)^3 (1.275 \cdot 10^3 \frac{\text{d}}{\text{m}^2 \text{ s}}) (2.88 \cdot 10^4 \text{ s}) (1.2 \cdot 10^7 \text{ m}^2) \approx$$

$$1.477 \cdot 10^7 \text{ m}^3 \times \frac{1 \text{ acre-foot}}{1235.9 \text{ m}^3} = \boxed{1.195 \cdot 10^4 \text{ acre-feet}} \quad 20$$

$$\text{Joules} = \text{energy} = \text{kgm}^2/\text{s}^2 = \text{kg m}^2 \text{s}^{-2}$$

$$\text{kgm}^2 \text{s}^{-2} = \text{N k}^a \text{X}^b \quad \text{k} = \frac{\text{N}}{\text{m}} = \frac{\text{kg}}{\text{s}^2} = \text{kg s}^{-2}$$

$$\text{kgm}^2 \text{s}^{-2} = \text{N kg}^a \text{s}^{-2a} \text{m}^b$$

$$\boxed{\begin{array}{l} a=1 \\ b=2 \end{array}}$$

$$\therefore \text{kg}^1 = \text{kg}^a$$

$$\text{m}^2 = \text{m}^b$$

$$\text{s}^{-2} = \text{s}^{-2a}$$

$$\therefore a=1, b=2$$