

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?

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

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

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

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

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

Explain

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

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

Explain

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Calculation Questions: Follow homework format. Make sure pages are in order.

1. The meter is the base SI unit of length, the second is the base SI unit of time and the base SI unit of mass is the kilogram.
- Force has dimensions of mass multiplied by acceleration. What are the units of force in terms of the base SI units?
 - Pressure has dimensions of force per area. What are the units of pressure in terms of the base SI units?
 - Energy has dimensions of force multiplied by distance. What are the units of energy in terms of the base SI units?
 - Gravitational potential has dimensions of energy per mass. What are the units of gravitational potential in terms of the base SI units?
 - The bulk modulus is a measure of the 'squishiness' of a substance. It is defined as the volume of the material multiplied by the ratio of pressure over volume. What are the SI units for the square root of (the bulk modulus divided by density)?
 - The linear mass density is the mass of an object divided by its length. What are the SI units for the square root of (Force divided by linear mass density)?
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2. The speed (v) of a wave on a string depends on the tension (F_T) applied to the string and the mass per unit length (M/L) of the string. Use dimensional analysis to find the values of the constants (a and b) in the equation for the speed of a wave traveling on a string given that

$$v = (\text{numerical constant}) F_T^a (M/L)^b$$

*Please note that you are to derive the result, **not** look it up.*

3. Hydraulic engineers use a particular unit of volume called the acre-foot, representing a surface area of a single acre covered to a depth of one foot with water.
- How many cubic meters in a single acre-foot?
 - How much mass is contained in one acre-foot of water?
 - If water were pumped through a hose at a rate of 1000 liters per minute, how many seconds would it take for a single acre-foot to be pumped?
 - If a single raindrop has a radius of 2mm, and 1275 raindrops strike an area of 1m^2 each second, and the rainstorm lasts for 8 hours, how many acre-feet of water are deposited in an area measuring 3km by 4km?
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4. The potential energy function (U) of a mass attached to a spring depends on the mass (m) of the object and the spring force constant (k) where k is measured in Newtons per meter (N/m) and U is measured in Joules (J). Use dimensional analysis to find the values of the constants (a and b) in the equation given that

$$U = (\text{numerical constant}) k^a x^b$$

*Please note that you are to derive the result, **not** look it up.*

Due on or before 9/4