Physics 23 Problem Set 1

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Due Monday, September 26

Please make your work neat, clear, and easy to follow. It is hard to grade sloppy work accurately. Generally, make a clear diagram, and label quantities. Derive symbolic answers, and then plug in numbers after a symbolic answer is available.

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1. This is a problem about working partial derivatives, for a particularly useful example of a function. The function is:

$$f_{\pm}(x,t) = A \times e^{i(kx \pm \omega t)}$$

where A, k, and ω are real-valued constants, $i = \sqrt{-1}$, x is position, and t is time.

Compute

(a) $\frac{\partial}{\partial x} f_{\pm}(x,t)$

(b) $\frac{\partial}{\partial t} f_{\pm}(x,t)$

(c) $\frac{\partial^2}{\partial x^2} f_{\pm}(x,t)$

(d) $\frac{\partial^2}{\partial t^2} f_{\pm}(x,t)$

(e) Evaluate whether $f_{\pm}(x,t)$ satisfies the wave equation:

$$\frac{\partial^2}{\partial x^2} f_{\pm}(x,t) = \frac{1}{v^2} \frac{\partial^2}{\partial t^2} f_{\pm}(x,t)$$

when there is a specific relationship (that you must find, if it exists) between k, ω, and v.

(f) For a certain mathematical relationship between x and t, $f_{\pm}(x,t)$ is a constant (a complex-valued constant). Express that relationship in the mathematical form $x = g(t)$, and derive two forms for $g(t)$: i)in terms of t, ω, and k, and ii)in terms of t and v.
