

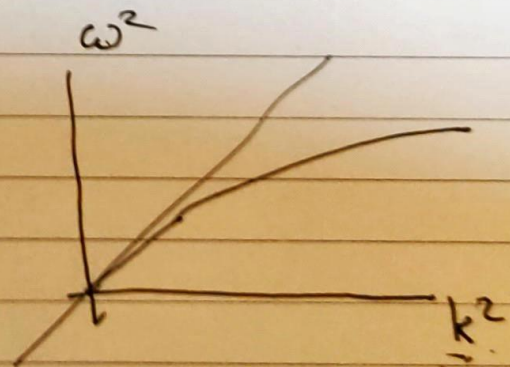
$$e^{+xz} \cos(\omega t - kx)$$

$$\boxed{\omega^2 = gk}$$

$$[\omega] = \frac{1}{\text{sec}}$$

$$[k] = \frac{1}{\text{cm}}$$

$$[g] = \frac{\text{cm}}{\text{sec}^2}$$



$$\omega^2 = gk \tanh kh$$

$$kh \ll 1$$

$$\omega^2 \approx gk^2 - gh^3 k^4 + \dots$$

$$\tanh x = x - \frac{x^3}{3}$$

$$\omega^2 = \sqrt{ghk^2 - gh^3 k^4} =$$

$$= \sqrt{gh} k \sqrt{1 - \frac{h^2 k^2}{3}} \approx \sqrt{gh} k - \frac{gh^3 h^{5/2}}{6} k^3$$



$$\lambda \gg h \rightarrow kh \ll 1$$

Shallow water

$$\lambda \ll h \quad kh \gg 1$$

Deep water

$$\rho(\xi + h) = m \quad \rho(\xi + h)v = I$$

$$\frac{\partial m}{\partial t} + \frac{\partial I}{\partial x} = 0$$

$$\left[\frac{\partial \xi}{\partial t} + \frac{\partial v}{\partial x} h = 0 \right] \quad \left[\frac{\partial \xi}{\partial t} + \frac{\partial v}{\partial x} h = 0 \right]$$

$$\rho \frac{\partial v}{\partial t} + \frac{\partial}{\partial x} \rho g(h + \xi) = 0$$

$$(\nabla \cdot \nabla)$$

$$\frac{\partial v}{\partial t} = -g \frac{\partial \xi}{\partial x}$$

$$\frac{\partial^2 \xi}{\partial t^2} = -g \frac{\partial^2 \xi}{\partial x^2}$$

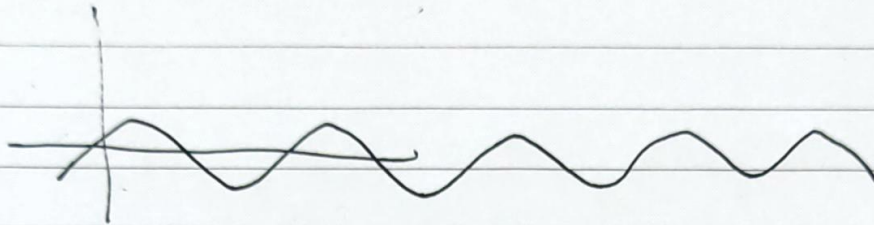
$$\frac{\partial^2 v}{\partial x^2} = -g \frac{\partial^2 \xi}{\partial x^2}$$

$$\left[\frac{\partial^2 \xi}{\partial t^2} = g h \frac{\partial^2 \xi}{\partial x^2} \right]$$

$$\omega^2 = s^2 k^2$$

$$\left[s = \sqrt{gh} \right]$$

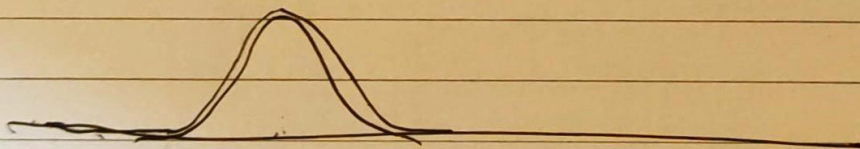
$$\frac{\partial^2 \xi}{\partial t^2} = \frac{\partial^2 \xi}{\partial x^2} + \frac{\partial^2 \xi}{\partial x^4}$$



st - x

$$\xi = u(st - x)$$

$$\frac{\partial u}{\partial t} = u \frac{\partial u}{\partial x} - \frac{\partial^3 u}{\partial x^3}$$



$$\frac{1}{\cosh^2}$$

$$u(x, t) = A f\left(\frac{x - ct}{a}\right)$$

$$\frac{\partial u}{\partial t} \sim A f' \frac{c}{a}$$

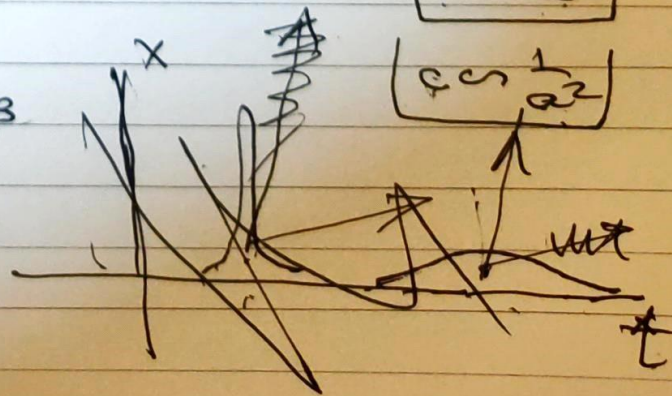
$$A \frac{c}{a} \sim A^2 \frac{1}{a} \sim \frac{A}{a^3}$$

$$u \frac{\partial u}{\partial x} \sim A^2 f f' \frac{1}{a}$$

$$A \sim \frac{1}{a^2}$$

$$\frac{\partial^3 u}{\partial x^3} \sim A f''' \frac{1}{a^3}$$

$$c \sim \frac{1}{a^2}$$



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