

1. Mechanical waves 機械波(力學波)

2. EM waves 電磁波.

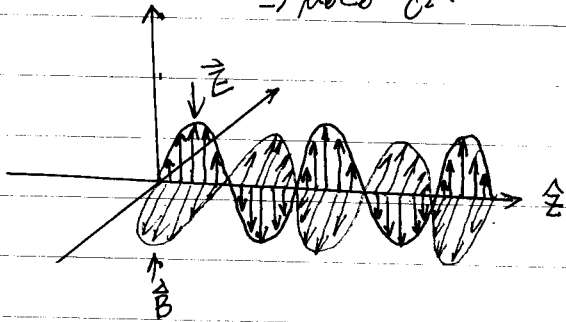
Maxwell 方程式.

1. 高斯定律 $\nabla \cdot \vec{E} = \frac{\rho}{\epsilon_0}$

2. 磁單極不存在 $\nabla \cdot \vec{B} = 0$

3. 法拉第電感定律 $\nabla \times \vec{E} + \frac{\partial \vec{B}}{\partial t} = 0 \Rightarrow \nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$

4. 安培定律 $\nabla \times \vec{B} = \mu_0 \vec{j} + \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$
 $\Rightarrow \mu_0 \epsilon_0 = \frac{1}{c^2}$



3. Matter waves.

$$E = h\nu \quad (\text{普朗克方程式})$$

[古典]

$$m\frac{v^2}{r} = \frac{1}{4\pi\epsilon_0} \frac{q^2}{r^2} \quad \odot$$

$$\Rightarrow \frac{v^2}{r} = \frac{9.0 \times 10^9}{9.31 \times 10^{-31}} \times \frac{(1.6 \times 10^{-19})^2}{(5.3 \times 10^{-11})^2} \approx 1.5 \times 10^6 \frac{m}{s}$$

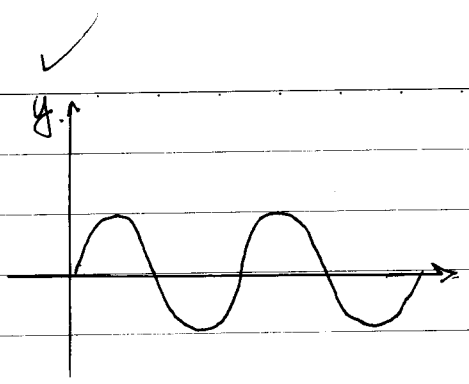
 $* a \approx 1.5 \times 10^{18} \frac{m}{s^2}$

$$E = h\nu = \frac{hc}{\lambda}$$

$$P = \frac{h}{\lambda}$$

$$\lambda = \frac{h}{P}$$

↳ 輻射散出 \Rightarrow 質量 \downarrow

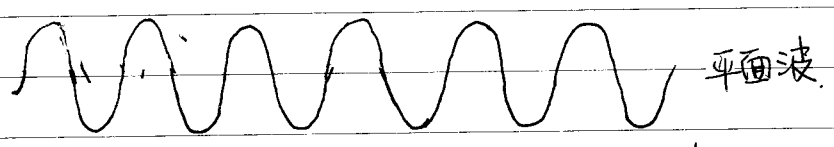


Amplitude A (振幅) phase (項)

$$y(x,t) = y_0 \sin(kx - \omega t) + \phi$$

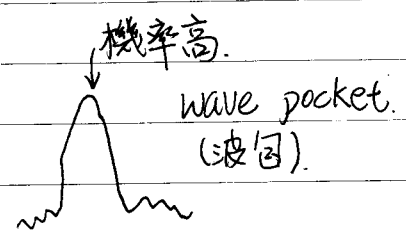
$$= y_0 \sin \left[k(x + \frac{\omega}{k}t) \right]$$

波峰傳播速度 wave number



平面波

traveling wave.



speed $kx - \omega t = \text{const.}$

$$k \frac{dx}{dt} - \omega = 0 \Rightarrow \frac{dx}{dt} = v = \frac{\omega}{k} (\rightarrow) \text{ cf. } \frac{dx}{dt} = -v = -\frac{\omega}{k} (\leftarrow)$$

$$y(x,t) = \sqrt{ax+bt} \quad y(x,t) = \sin(ax^2 - bt) x$$

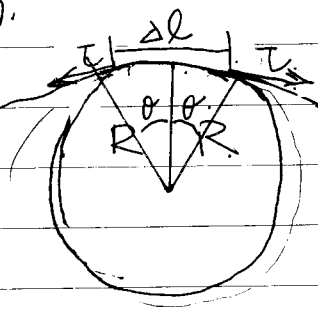
$$y(x,t) = 0.00327 \sin(72.1x - 2.72t) \text{ m.}$$

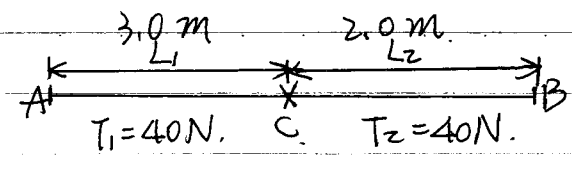
Amp. = 3.27 mm $\omega = 2.72 \text{ rad/s}$
 $k = 72.1 \text{ rad/m}$ $\lambda = \frac{2\pi}{k} = 8.71 \text{ cm}$, $T = \frac{2\pi}{\omega} = 2.3 \text{ s}$
 $f = \frac{1}{T} = 0.433 \text{ Hz}$
 $v = \frac{\omega}{k} = 3.77 \text{ cm/s}$ #

const. = 1 Force. 繩張力 = tension.
 $* v = c \sqrt{\frac{T}{\mu}}$

density $\mu = \frac{m}{l}$ $\Delta m = \mu \Delta l$
 $F = 2T \sin \theta \approx 2T\theta$

$F = ma$
 $\Rightarrow F = 2T\theta = T \frac{\Delta l}{R}$
 $T = \frac{\Delta l}{R} = (\mu \Delta l) \frac{v^2}{R}$
 $v^2 = \frac{T}{\mu}$





$$\mu_1 = 1.4 \times 10^{-4} \text{ kg/m}$$

$$\mu_2 = 2.8 \times 10^{-4} \text{ kg/m}$$

*求 A → C → B 之 time? 1.67, 1.44 (s)