



شركة تدريب هندسي

E. CAMP



الطريق الدائري بجوار المدرسة المعمارية



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PHYSICS 1

2021 - 2022 **No.14**

"CH. 6 : Waves"

الموجات

[1] Waves: Disturbance that carries energy through matter or space.

هو اضطراب يحمل الطاقة خلال وسط أو فراغ

[2] Electromagnetic Waves: الموجات الكهرومغناطيسية

• Do not required a medium لا تحتاج وسط

• Examples: Visible Light - Radio Waves

[3] Mechanical Waves:

• Required a medium to travel.

• Examples: Water Waves and sound Waves

(A) Transverse Waves: الموجات المستعرضة

• Example: Water Waves

• Have crests and troughs.

• The wave motion is perpendicular to the particles motion.

crest قمة

amplitude

trough قاع

عمودي

(b) Longitudinal Waves: الموجات الطولية

• Example: Sound Waves



• Have compressions and rarefraction تضاغطات تخلخلات

• The Wave motion is Parallel to the Particles motion.

* ملخص قوانين ال Waves

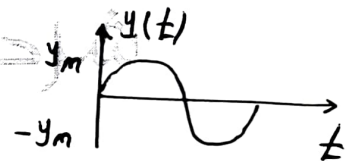
$$1 \quad f = \frac{1}{T}$$

$$2 \quad v = \lambda f$$

$v \rightarrow$ wave velocity (m/s)

$\lambda \rightarrow$ wavelength (m)

$$3 \quad y(x,t) = y_m \sin(kx - \omega t)$$



$y \rightarrow$ displacement

$y_m \rightarrow$ maximum displacement

$$4 \quad \omega = 2\pi f \quad \text{rad/s} \quad \text{angular velocity}$$

$$5 \quad k = \frac{2\pi}{\lambda} \quad \text{rad/m} \quad \text{angular wave number}$$

6 Velocity:

$$V(x, t) = -\omega y_m \cos(Kx - \omega t) \quad , \quad V_{max} = \omega y_m$$

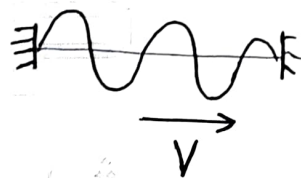
7 acceleration:

$$a(x, t) = -\omega^2 y_m \sin(Kx - \omega t) \quad , \quad a_{max} = \omega^2 y_m$$

$$a = -\omega^2 y$$

8 Wave Speed on a stretched string:

$$v = \sqrt{\frac{\tau}{\mu}} \quad \text{m/s}$$



$\tau \rightarrow$ Tension force (N) قوة الشد

$\mu \rightarrow$ mass per unit length (kg/m)

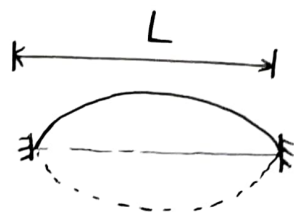
$$\mu = \frac{m}{L} \quad \text{الكتلة لوحدة الأطوال}$$

(Linear density)

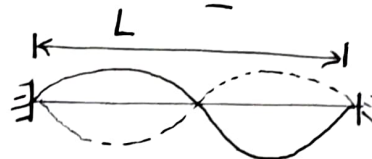
9 Transmitted Power: (energy rate)

$$\bar{P} = \frac{1}{2} \mu v \omega^2 y_m^2 \quad \text{Watt}$$

10 Resonance frequency:



First harmonic
($n=1$) one loop
حلقة واحدة



Second harmonic
($n=2$) two loops

EX.1: $y(x, t) = 0.00327 \sin(72.1x - 2.72t) \text{ m}$

- What is the amplitude?
- What is the wavelength and Period?
- What is the frequency and speed?

~ answer ~

(a) $y_m = 0.00327 \text{ m}$

(b) $k = 72.1$

$$\therefore k = \frac{2\pi}{\lambda} \rightarrow \lambda = \frac{2\pi}{k} = \frac{2\pi}{72.1} = \boxed{0.087 \text{ m}}$$

$$\therefore \omega = 2\pi f = \frac{2\pi}{T}$$

$$\therefore T = \frac{2\pi}{\omega} = \frac{2\pi}{2.72} = \boxed{2.31 \text{ s}}$$

$$(c) f = \frac{1}{T} = \frac{1}{2.3} = \boxed{0.433 \text{ Hz}}$$

$$V = \lambda f = 0.087 \times 0.433 = \boxed{0.0377 \text{ m/s}}$$

EX. 2: $y(x, t) = 0.0327 \sin(72.1x - 2.72t)$

Find (a) Displacement $x = 22.5 \text{ cm}$
 $t = 18.9 \text{ s}$

(b) velocity and acceleration

~ answer ~

$$(a) y(22.5 \text{ cm}, 18.9) = 0.0327 \sin(72.1 \times 22.5 \times 10^{-2} - 2.72 \times 18.9)$$

\downarrow rad

$$= \boxed{0.00192 \text{ m}}$$

$$(b) V = 0.0327 (-2.72) \cos(72.1 \times 22.5 \times 10^{-2} - 2.72 \times 18.9)$$

$$= \boxed{0.0072 \text{ m/s}}$$

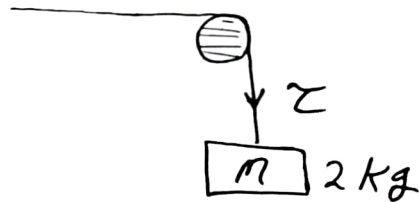
$$a = -0.0327 (2.72)^2 \sin(72.1 \times 22.5 \times 10^{-2} - 2.72 \times 18.9)$$

$$= \boxed{0.0142 \text{ m/s}^2}$$

EX.3: A uniform cord has a mass of 0.3 kg and length of 6 m, the cord passes over a pulley and supports a 2 kg object. Find the speed of pulse traveling along this cord.

~ answer ~

$$* T = mg$$



$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{2 \times 9.81}{0.3/6}} = \boxed{19.8 \text{ m/s}}$$

EX.4: A string has $\mu = 525 \text{ g/m}$ and

$$T = 45 \text{ N}, f = 120 \text{ Hz}, y_m = 8.5 \text{ mm}$$

What is the average power does the wave transport (energy rate)?

~ answer ~

$$\omega = 2\pi f = 2\pi \times 120 = 754 \text{ rad/s}$$

$$v = \sqrt{\frac{T}{\mu}} = \sqrt{\frac{45}{525 \times 10^{-3}}} = 9.26 \text{ m/s}$$

$$P = \frac{1}{2} \mu v \omega^2 y_m^2 = \frac{1}{2} (525 \times 10^{-3}) \times (9.26)^2 \times (754)^2 \times (8.5 \times 10^{-3})^2 = \boxed{100 \text{ W}}$$