Physics 132 Prof. W. Losert

Outline

Waves

Midterm II FRIDAY

Office hours in Course Center Thursday 1-2 and 5-6.30

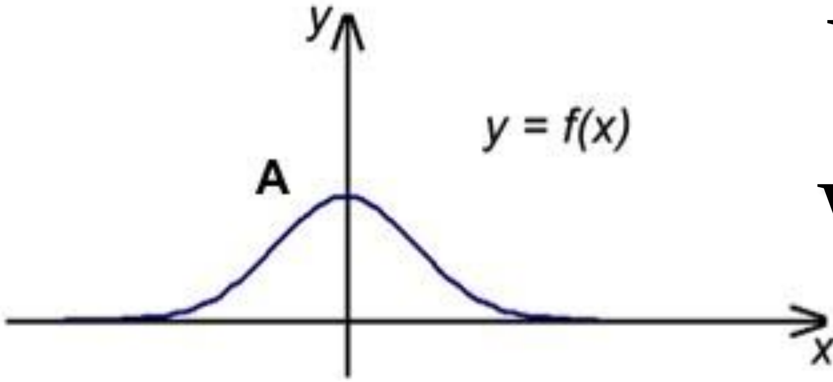
Foothold principles: Mechanical waves

- *Key concept*: We have to distinguish the motion of the bits of matter and the motion of the pattern.
- *Mechanism*: the pulse propagates by each bit of string pulling on the next.
- *Pattern speed*: a disturbance moves into a medium with a speed that depends on the properties of the medium (but not on the shape of the disturbance)

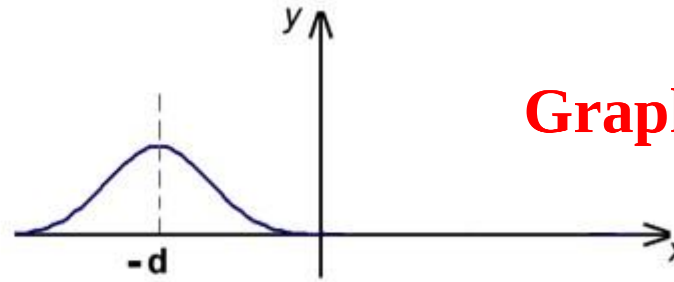
$$v_0 = \sqrt{T/m}$$

v_0 = speed of pulse
T = tension of spring
μ = mass density of spring (M/L)

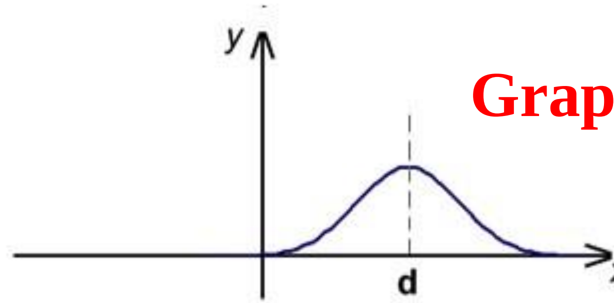
- *Matter speed*: the speed of the bits of matter depend on both the size and shape of the pulse and pattern speed.



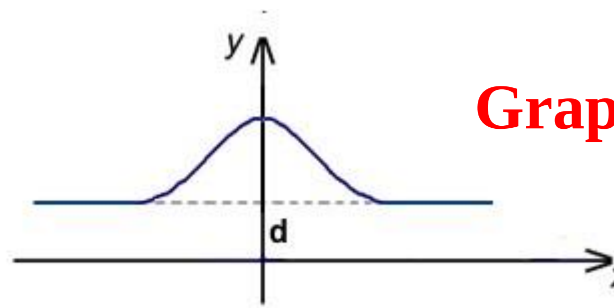
Which goes with which?



Graph I



Graph II



Graph III

1. $y = f(x + d)$
2. $y = f(x - d)$
3. $y = f(x) + d$
4. $y = f(x) - d$
5. You can't tell if you don't know the form of f.
6. You can't tell for some other reason.

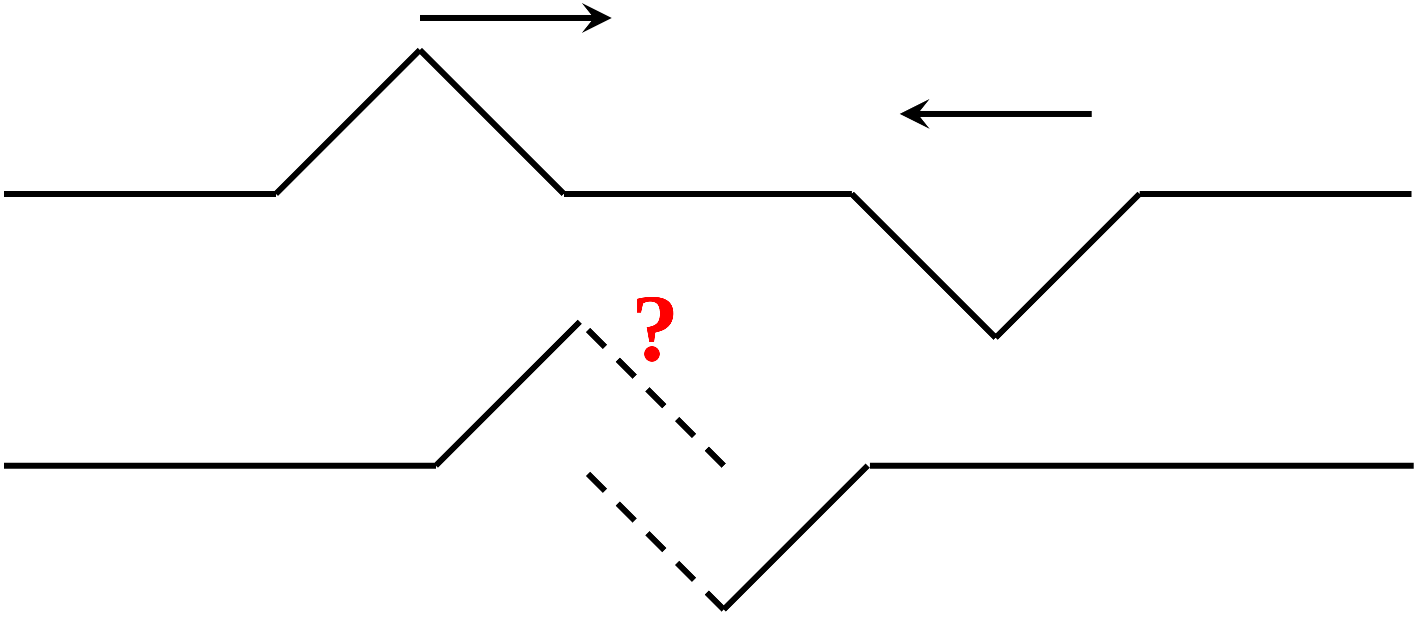
The math

- We express the position of a bit of string at a particular time by labeling which bit of string by its *x* position, at x at time *t* the position of the string is $y(x,t)$.
- Since subtracting a *d* from the argument of a function ($f(x) \to f(x - d)$) shifts the graph of the function to the right by an amount *d*, if we want to set the graph of a shape $f(x)$ into motion at a constant speed, we just need to set $d = v_0 t$ and take

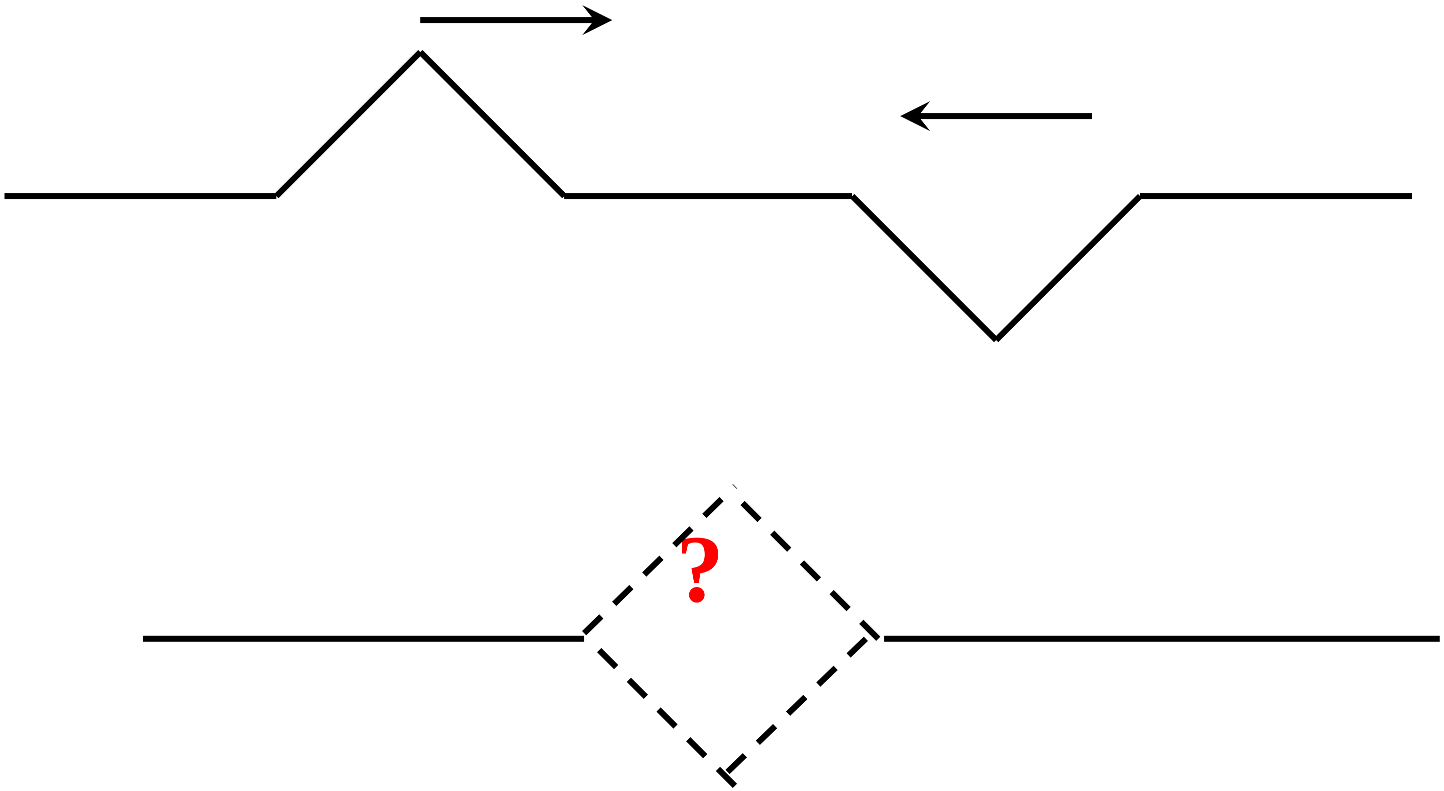
$$f(x) \to f(x - v_0 t)$$

How do waves combine?

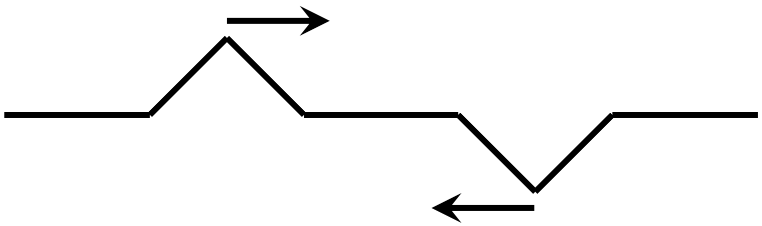
We know how one wave moves.
What happens when we get two waves on top of each other?

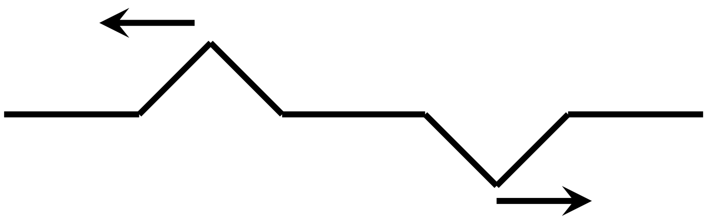


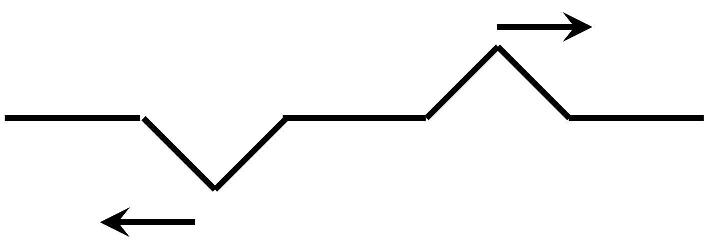
What happens when they overlap perfectly?



What happens after the waves collide?

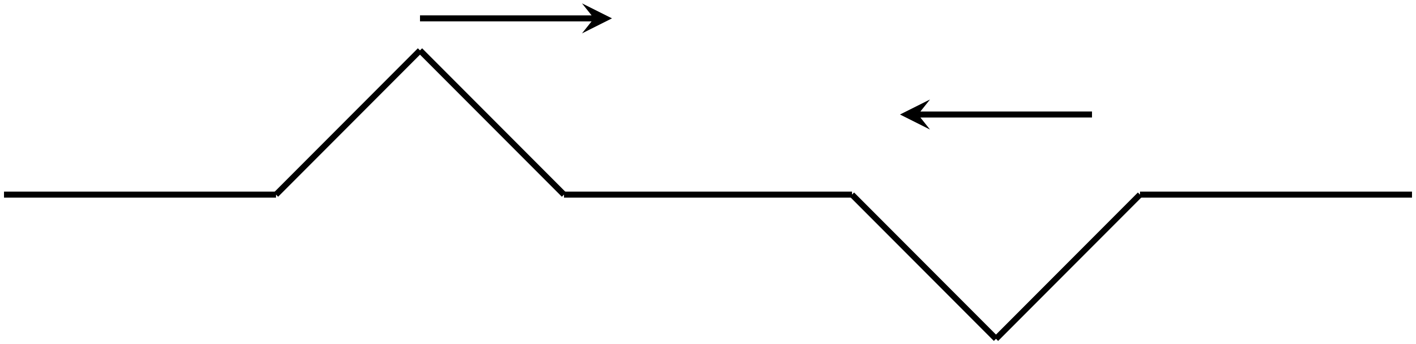


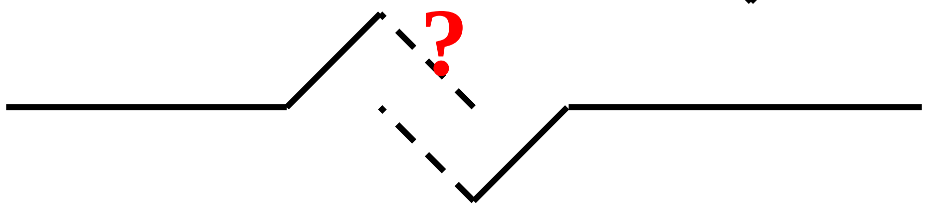
1.  (Bounce off)

2.  (Pass through)

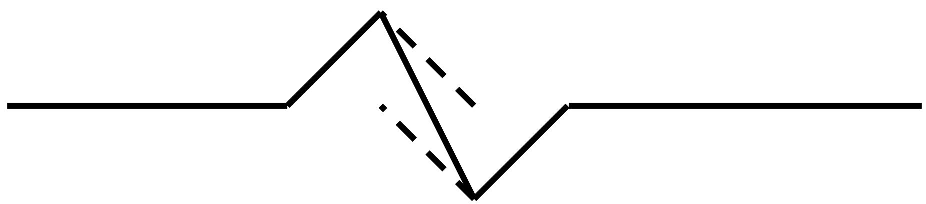
3. (Cancel)

4. Other

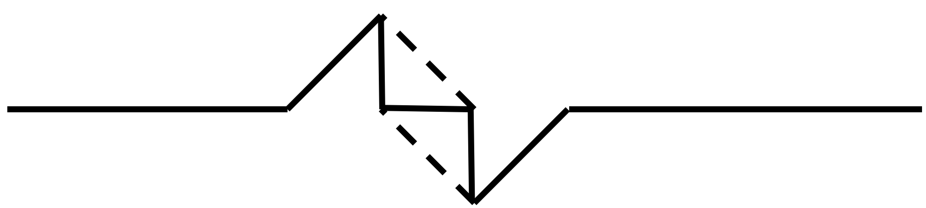




1.

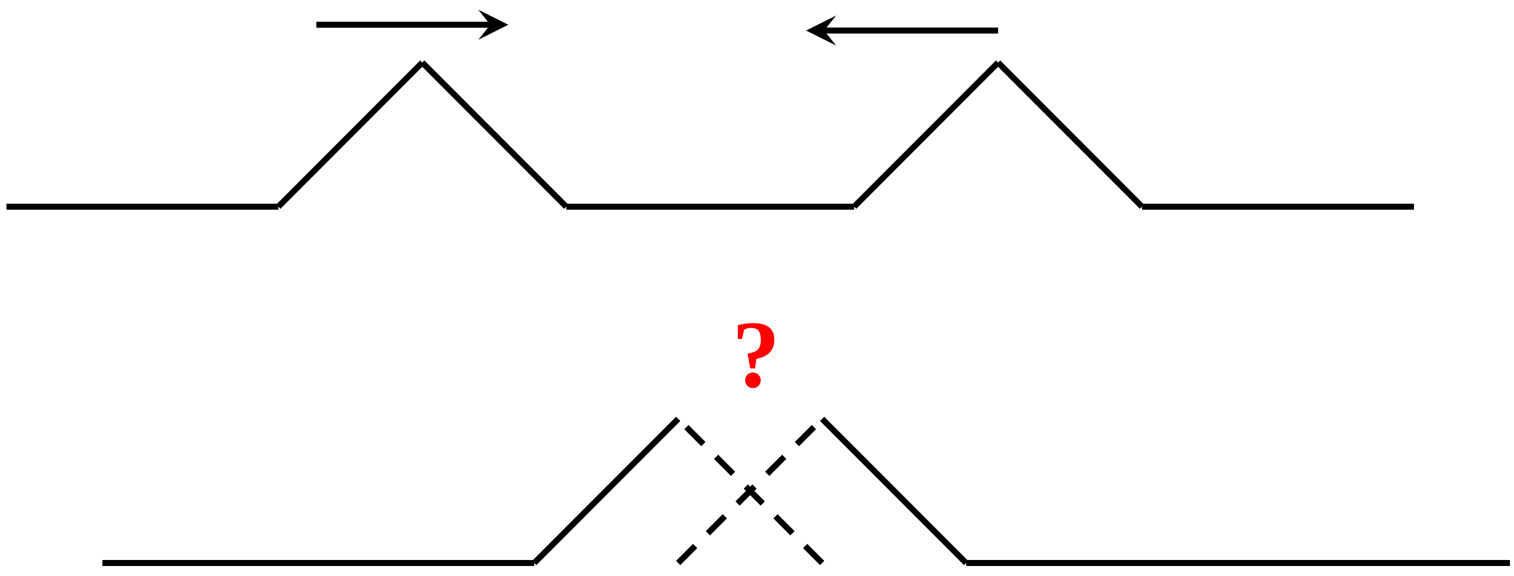


2.



3. Other

How about on the same side?



Sinusoidal waves

- Suppose we make a continuous wiggle. When we start our clock (t = 0) we might have created shape something like

$$y(x,0) = A\sin kx$$

Why do we need a "*k*"

- If this moves in the +x direction, at later times it would look like

$$y(x,t) = A\sin k(x - v_0 t)$$