```
from aide_design.play import*
from coastal import*
from scipy import optimize
```

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Problem Set 2

1i. Find the wave speed and wavelength.

$$c_p = \frac{\lambda}{T} = \frac{\sigma}{k}$$

$$\lambda = \frac{2\pi}{k}$$

$$\sigma^2 = g \cdot k \cdot tanh(kh)$$

Rearrange the dispersion equation to solve for k, wave number, alone.

$$\left(\frac{2\pi}{T}\right)^2 = g \cdot k \cdot tanh(kh)$$

$$0 = g \cdot k \cdot tanh(kh) - \left(\frac{2\pi}{T}\right)^2$$

```
period = 4 * u.s
height = 5 * u.m
g = 9.80665 * u.m/u.s**2

k_number = wavenumber(period, height, 0.1, 3)
wave_length = wavelength(k_number)
wave_speed = celerity(wave_length, period)
```

Parameter	Value
k	0.2831
wavelength	22.19 m
wave speed	5.548 m/s

1ii. Find the component water parcel velocities (u,w) and the pressure a distance 2 meters below the still water level and under the wave crest.

Parameter	Value
u velocity	1.121 m/s
w velocity	0 m/s
pressure (z = -2m)	25.76 kPa
pressure crest (z = 1m)	2.888 kPa

```
z = -2 * u.m
z_crest = 1 * u.m
x = 0 * u.m
t = 0 * u.s
temp = 20 * u.degC
amp = 1 * u.m

vel_u = velocity_u(period, height, amp, t, x, z)
vel_w = velocity_w(period, height, amp, t, x, z)
pressure = pressure_wave(period, height, amp, t, x, z, temp)
pressure_crest = pressure_wave(period, height, amp, t, x, z_crest, temp)
```

2ai. Find the minimum height of the seawall to prevent flooding.

The minimum height of the seawall is sum of the depth of the water and twice the amplitude of the waves.

$$H_{wall,min} = h + 2a$$

```
height_design = 3 * u.m
amp_design = 0.5 * u.m
height_wall = 2 * amp_design + height_design
```

The minimum wall height is 4 meters.

2aii. Find the maximum force on the seawall.

From Dean and Dalmrymple, the first order wave force equation is as follows:

$$F = \rho\frac{gh^2}{2} + \rho gh\left(\frac{tanh(kh)}{kh}\right)\eta_w$$

The maximum force occurs when:

$$\eta = H/2$$

This substitution results in the maximum force for a wave on a wall equation.

$$F_{max} = \rho g\left(\frac{4h^2 + H^2}{8}\right) + \rho gh\frac{H}{2}\left(\frac{tanh(kh)}{kh}\right)$$

```
period_design = 10* u.s
force_max = force_max(period_design, height_design, amp_design, temp)
```

The maximum force exerted on the wall is 59.3 kN.

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