

## Chapter 1

# Example problem: Solving the Helmholtz equation on an unstructured mesh

In this document we revisit the solution of the Helmholtz equation and demonstrate how to simulate the scattering of a planar wave from a circular cylinder using an unstructured mesh.

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### 1.1 A specific example: Scattering of an acoustic wave from a sound-hard obstacle.

We revisit the problem considered in [another tutorial](#): the scattering of a planar sound wave impacting on a rigid, impermeable obstacle as shown in this sketch:



Figure 1.1 Scattering of an incoming wave from a sound-hard obstacle -- the scatterer.

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### 1.2 Results

The figure below shows plots of the real and imaginary parts of the fluid's displacement potential  $\phi$  (a measure of the fluid pressure). The red and green lines correspond to the computed and exact analytical solutions, respectively. (We refer to [another tutorial](#) for details.)



Figure 1.2 Real part of the displacement potential (red: computed; green: exact).



Figure 1.3 Imaginary part of the displacement potential (red: computed; green: exact).

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## 1.3 The numerical solution

The driver code for this problem is very similar to the one discussed in [another tutorial](#). Running `sdiff` on the two driver codes

```
demo_drivers/helmholtz/scattering/scattering.cc
```

and

```
demo_drivers/helmholtz/scattering/unstructured_scattering.cc
```

shows you the differences, the most important of which are:

- the setup of the unstructured mesh, ensuring that mesh adaptation respects the curvilinear boundaries.
- the re-assignment of element properties following any mesh adaptation – we refer to [another tutorial](#) for a more detailed discussion of why this is necessary.

That's all!

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## 1.4 Source files for this tutorial

- The source files for this tutorial are located in the directory:

```
demo_drivers/helmholtz/scattering/
```

- The driver code is:

```
demo_drivers/helmholtz/scattering/unstructured_scattering.cc
```

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## 1.5 PDF file

A [pdf version](#) of this document is available.