In [1]:

```
import numpy as np
import matplotlib.pyplot as plt
```

In [2]:

```
def f(x):
    return np.sin(x)

def df(x):
    return np.cos(x)
```

In [3]:

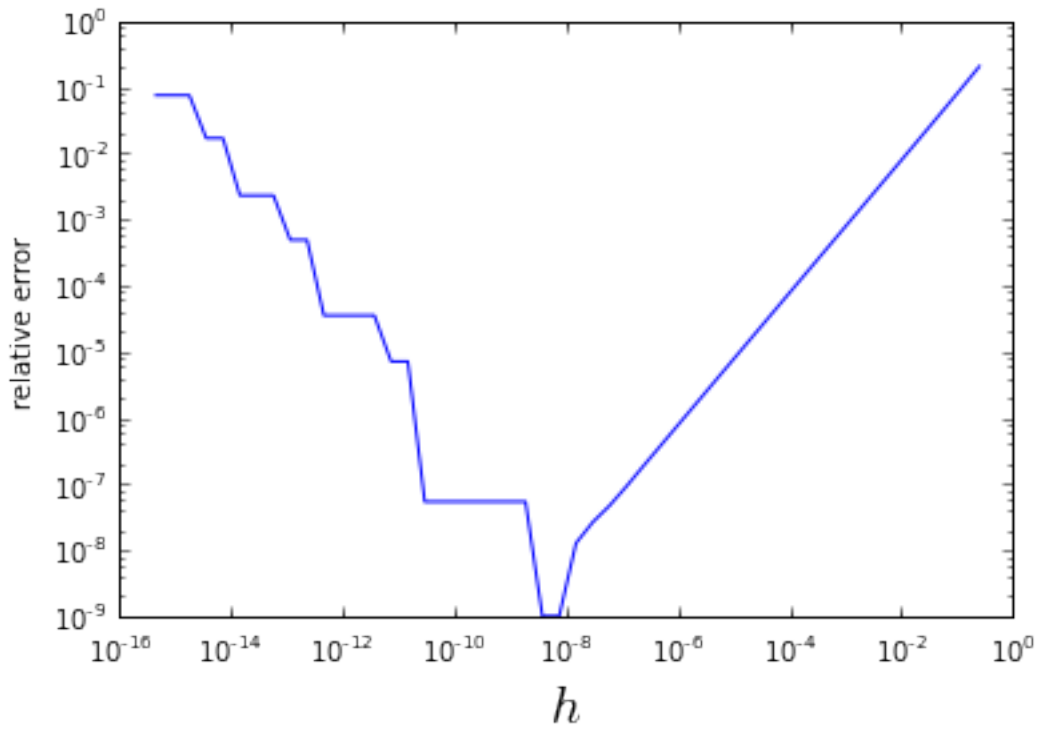
```
h = 0.25
x = 1.0

hs = []
errs = []

dfexact = df(x)

while h > 0:
    dfapprox = (f(x+h) - f(x)) / h
    hs.append(h)
    errs.append(abs(dfexact - dfapprox)/dfexact)

    h /= 2.0
```

In [7]:

```
%matplotlib inline
plt.loglog(hs[:50], errs[:50])
plt.xlabel(r'$h$', fontsize=20)
plt.ylabel('relative error')
```

Out[7]:

```
<matplotlib.text.Text at 0x11447d3c8>
```



In [8]:

```
f(x + 1e-8)
```

Out[8]:

```
0.84147099021091942
```

In [9]:

```
f(x)
```

Out[9]:

```
0.8414709848078965
```

In [10]:

```
f(x + 1e-8) - f(x)
```

Out[10]:

```
5.4030229179602429e-09
```

In [11]:

```
(f(x + 1e-8) - f(x))/1e-8
```

Out[11]:

```
0.540302291796024 29
```

In [ ]:

```

```