Practice 4.2

Practice sheets are not assessed. The intention is to use material from lectures in preparation for Competence tests and Assignments. You are encouraged to use `thing.[TAB]` and `thing?` in IPython.

Notes

See Material 4

```
import sympy as sp
x,y,z = sp.symbols('x y z')
```

If you would prefer the display to look a little more like written mathematics, use the following:
`sp.init_printing(use_unicode=True)`

When defining a symbol, we can specify things about it:

```
x = sp.symbols('x', real=True) # tells Python that x is a real value i.e. not complex
x = sp.symbols('x', positive=True) # tells Python that x > 0
```

In sympy infinity is represented by two letter "o" s i.e. `sp.oo`.
The sympy function `sp.N` can be used to convert an expression into a numeric value, e.g.

```
a = sp.sqrt(sp.pi)
a, sp.N(a)
```

```
(sqrt(pi), 1.77245385090552)
```

Symbolic computing

Find the analytical value of the integral $\int_0^1 \cos\left(-x^2\right)dx$.
Convert this to a number using `sp.N`, and compare with the numerical value obtained by using `quad`.

Find the maximum of

$$y = x\,\exp\left[-x^2\right].$$

***Hint**: Make an expression for `y`; differentiate with resepect to `x`; solve for `x` for this equal to zero.*

Find the normalisation constant for

$$\psi(x) \propto \exp\left[-\frac{m\omega}{2\hbar}x^2\right].$$

***Hint**: Tell Python that m, $\hbar$, and ω are positive quantities. Integrate from $-\infty$ to $+\infty$.*

Now do all of the above in Mathematica.