Canonical commutation relation in one dimension:

$$XP - PX = i\hbar$$

Let

$$X = x, \quad P = -i\hbar\frac{\partial}{\partial x}$$

Then

$$\begin{aligned}(XP - PX)\psi(x,t) &= XP\psi(x,t) - PX\psi(x,t) \\ &= x\left(-i\hbar\frac{\partial}{\partial x}\psi(x,t)\right) + i\hbar\frac{\partial}{\partial x}\big(x\psi(x,t)\big) \\ &= -i\hbar x\frac{\partial}{\partial x}\psi(x,t) + i\hbar\left(\frac{\partial}{\partial x}x\right)\psi(x,t) + i\hbar x\frac{\partial}{\partial x}\psi(x,t) \\ &= i\hbar\psi(x,t)\end{aligned}$$

Eigenmath code:

```
X(f) = x f
P(f) = -i hbar d(f,x)
X(P(psi(x,t))) - P(X(psi(x,t)))
```

Result:

$$i\hbar\psi(x,t)$$

Another example: Show that

$$[X^2, P^2] = 2i\hbar(XP + PX)$$

Eigenmath code:

```
X2(f) = X(X(f))
P2(f) = P(P(f))
A = X2(P2(psi(x,t))) - P2(X2(psi(x,t)))
B = 2 i hbar (X(P(psi(x,t))) + P(X(psi(x,t))))
check(A == B)
"ok"
```

Result:
ok

(The statement `check(A == B)` halts if A not equal B.)