Mathematica Examples for Physics 3180

Symbolic Derivatives and Substitutions

```
z = 1 + E^(-b eps)
```

$$1 + E^{-(b\ eps)}$$

Here I've defined a new symbol, z, to stand for the expression 1 + e^(-b eps). *Mathematica* doesn't have any built-in definitions of b or eps, so it just echoes my expression back. (I'm using "eps" as an abbreviation for "epsilon".) It's good practice to begin all user-defined symbols with lower-case letters, so they won't conflict with built-in *Mathematica* functions.

```
energy = -(1/z)D[z,b]
```

$$\frac{eps}{E^{b\ eps}\ (1 + E^{-(b\ eps)})}$$

To take the derivative of z with respect to b I typed D[z,b]. I also multiplied by -(1/z).

```
energy1 = Simplify[energy]
```

$$\frac{eps}{1 + E^{b\ eps}}$$

The preceding result was complicated, so I told *Mathematica* to simplify it.

```
eofT = energy1 /. b -> 1/(k t)
```

$$\frac{eps}{1 + E^{eps/(k\ t)}}$$

The combination "/." means "at the point": here I've told *Mathematica* to plug in 1/(kt) for b in the preceding expression. Notice that I need a space between k and t if these are to be treated as separate symbols.

Sums and Integrals

The syntax for sums and integrals is the same as for plots, although sums and integrals can have "Infinity" as the upper limit:

```
Sum[1 / n^2, {n, 1, Infinity}]
```

$$\frac{\pi^2}{6}$$

To get a numerical value, enclose the result in the N[ ] function:

```
N[Sum[1 / n^2, {n, 1, Infinity}]]
```

1.64493

```
Integrate[x^3/(E^x-1),{x,0,Infinity}]
```

$$\frac{Pi^4}{15}$$

Again, to get a numerical value you could use N[ ]. Alternatively, you can use the NIntegrate function, which does the integral numerically from the start:

```
NIntegrate[x^3/(E^x-1),{x,0,Infinity}]
```

6.49394