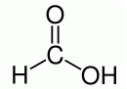
Exercises 12

1. Write a turtle command sequence which generates a balls-and-sticks molecule model of formic acid (structural formula: 

).
The atoms shall be represented by spheres with different sizes and colours (depending on the chemical element), and the bonds by cylinders (**`F(...)`** command of the turtle). The double bond shall be represented by a thicker cylinder.
Hint: The colour of an atom **`X`** can be specified as in the following example:

```
module X extends Sphere(1.0)
   {{ setShader(BLUE);}};
```

Test your solution with GroIMP.

2. (a) Write an L-system which simulates the primary growth of a plant in annual steps. The *annual shoots* of the vertical main axis (stem) shall all have the same length. The uppermost annual shoot shall bear an *apical bud* (= a red sphere) and a *lateral bud* (= a green sphere). The apical bud is supposed to produce a new annual shoot of the main axis next year, and from the lateral bud shall grow a shorter *lateral shoot* with a branching angle of 45°, which will terminate its growth next year (i.e., there are no buds at the lateral shoots). The positions of the lateral branches are alternating (left-right-left-right-...) along the stem. The simulation shall start with an apical bud.

(b) Modify the model by introducing a trend: Assume that the annual shoots get 10 per cent shorter each year.

(c) Assume additionally that the apical bud produces a flower (= a large blue cone) after 7 years, and that the plant then stops to grow.

Test your solutions with GroIMP.

Remarks: By **`M(-`***`s`***`)`** you can cause the turtle to move back along the main axis by stepsize *s*. **`Cone(`***`h, r`***`)`** stands for a cone with height *h* and radius *r*.

3. Open the example "Molecules" in GroIMP's built-in example portfolio ("File" / "Show Examples").
Make several model runs by clicking on the buttons "Run run" and "Reset", and observe what happens.
Now modify the model in the following ways:

(a) Increase the number of atoms from 10 to 20.
(b) Switch off the output of text to the console.
(c) Double the distance threshold for formation of a bond between two atoms.